THE EFFECTS OF ELECTRIC FIELDS ON BIOLOGICAL SYSTEMS

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Abstract - **The aim in this study was to examine protein synthesis in the liver tissue under the effect of exogenous electric fields applied in different intensitities and directions. Sixty male white guinea pigs, weighing 350-400 g were used for the study. The E field of 1.9 kV/m obtained from a DC (Direct Current) power supply with 300 V was applied in vertical direction to 10 guinea pigs, and in horizontal direction to other 10 guinea pigs. In the same manner, 0.9 kV/m obtained from a DC power supply with 150 V was applied in vertical direction to 10 guinea pigs, and in horizontal directions to other 10 guinea pigs. The remaining 20 guinea pigs were used as control without any E field exposure. Hydroxyproline level in the liver tissue was determined by the modified H.Stegemann-K.Stalder method. Horizontal and vertical application of electric field of 0.9 kV/m decreased the hydroxyproline level in liver tissue as compared to controls,whereas 1.9 kV/m electric field increased the level in both application directions. Vertical application of both of the electric fields was found more effective than the horizontal one, the differences being statistically significant.**

I.INTRODUCTION

Public concern has increased about the possible health risks of exposure to Electric (E) and Magnetic fields generated by electric power distribution systems.There is accumulating evidence from epidemiological studies that exposure to Electric and Magnetic Fields may increase the incidence of various types of cancer, particularly leukemia, brain tumors, and breast cancer [1,2].However, there is little understanding of the nature of the interaction between Electric and Magnetic Fields and biological systems.The observed effects include changes in enzyme activity and protein synthesis.The aim of this study is to examine protein synthesis under the effect of exogenous E fields in different directions and intensities.

II.MATERIALS AND METHODS

Electric Field Exposure

Guinea pigs (10-12 weeks old) were exposed continuously to uniform E fields of 1.9 kV/m- 0.9 kV/m generated between the parallel plates of a capacitor.The E field of 1.9 kV/m obtained from a DC (Direct Current) power supply with 300 V was applied in vertical direction to 10 guinea pigs and in horizontal direction to other 10 guinea pigs.In the same manner, 0.9 kV/m obtained from a DC power supply with 150 V was applied in vertical direction to 10 guinea pigs, and in horizontal directions to other 10 guinea pigs.Twenty guinea pigs were used as control without any E field exposure, but otherwise maintained under the same conditions.The guinea pigs were exposed to E fields for 3 days, 9 hours/day (between 8 a.m. and 5 p.m.) in wooden cages (50 cm x 50 cm x 14 cm) with copper plates mounted vertically or horizontally over them.

Determination of Tissue Hydroxyproline

Liver tissues hydroxyproline contents of animals were determined with Stegemann-Stalder's Method [3].

III. RESULTS

Hydroxyproline contents of liver tissues of the electric field applied groups were compared with their controls with DUNCAN Test.There was significant difference between hydroxyproline contents of the tissues of liver of vertical and horizontal electric field applied groups and control groups: Horizontal and vertical application of electric field of 0.9 kV/m decreased the hydroxyproline levels in liver tissues as compared to the controls,whereas 1.9 kV/m electric field increased the level in both application directions (Table 1, Fig. 1).Vertical application of both of the electric fields was found more effective than the horizontal one.

TABLE 1: Comparison of DC Electric Field Groups with Control Group and Statistical Evaluation

E Field	**Liver HP**
Vertical E Field (1.9kV/m)	0.559± 0.185**
Horizontal E Field (1.9 kV/m)	0.464± 0.180**
Control	0.261± 0.145
Vertical E Field (0.9kV/m)	0.077± 0.022**
Horizontal E Field (0.9 kV/m)	0.119± 0.030*

**: $p < 0.01$, *: $p < 0.05$, HP: Hydroxyproline (µg/g tissue)

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IV.DISCUSSION

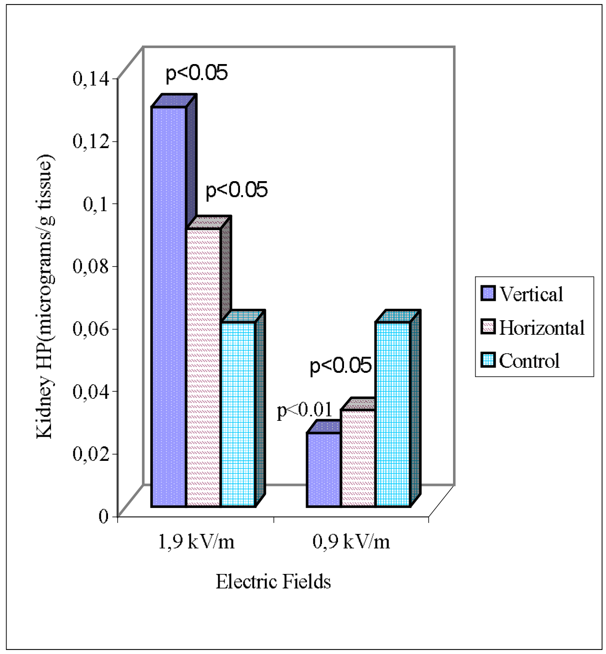
Electromechanical forces generated in the cell membrane by rapidly increasing elecroforces can lead to temporary reversible electronic collapse of the membrane [4-6]. DC fields of 1 kV/m have been shown to move protein molecules along the surface of the membrane and through gap junctions [7].

The changes found in our investigation in the levels of HP can be considered as the a result of transportation of molecules under the effect of applied.

The observed increase of hydroxyproline content under the influence of the electric field of 1.9 kV/m may be explained by the above mentioned facts:since proteins have a net electric charge depending on the pH value of the medium, and therefore are mobile within the electric field, the fibroblast cells move along the electric field, thus synthesizing more collagen, resulting in an increase in the HP content in the tissue. This increase in hydroxyproline content has also been substantiated with our histological findings [8]. The dense appearance of the fibroblasts in the histological picture of the tissue from this group supports the increase in hydroxyproline content. In livers of animals exposed to vertical electric field of 1.9 kV/m, the increase in collagen fibers is quite obvious in the areas where the connective tissue is dense.

In the 0.9 kV/m study, from both biochemical and histological point of view, decrease in collagen synthesis shows insufficient distbution for collagen fibers in the considered region [8,9]. Therefore, after 3 days E field exposure it is estimated that important defects and degeneration in the healty guinea pigs' liver tissue occur. Free radicals are defined as any atom, atomic group or molecule with an uncompensated spin.Toxic Oxgen Free Radicals are extremely reactive in general and can infict considerable damage to biomolecules, such as RNA, enzymes, membranes and proteins, which may lead to various pathological consequences [10].The increase in radicals can be traced with the variation in malondialdehyde (MDA) level [11]. In our study carried out in parallel to this study, contrary to 1.9 kV/m, both vertical and horizontal E fields of 0.9 kV/m caused an increase in MDA levels in the liver tissues of guinea pigs, whereas a decrease in the hydroxyproline levels of the liver tissues were observed. Reassessing the results of this study from this point of wiev, we may say that as a result of energy transfer of electric field to the applied tissue area, molecular O_2 could have been transformed to free radicals.The increase in free radicals may decrease molecular O_2 which is required for hydroxyproline synthesis.

Fig. 1: Changes in **liver** hydroxyproline levels upon the application of vertical and horizontal electric fields as compared to controls



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